IN-SITU FT-IR DIAGNOSTICS FOR MONITORING AND CONTROL OF FOSSIL FUEL COMBUSTION

Anthony S. Bonanno*, Marek A. Wójtowicz, Michael A. Serio, Chad M. Nelson, and Peter R. Solomon
Advanced Fuel Research, Inc., 87 Church Street, East Hartford, CT 06108
*On-Line Technologies, Inc., 87 Church Street, East Hartford, CT 06108

The use of FT-IR spectrometry as a Continuous Emission Monitor (CEM) in fossil fuel-fired power plants offers several advantages. A single instrument can be used to simultaneously monitor several pollutant species, thereby greatly reducing the cost and complexity of the CEM system. Additionally, the flexibility of FT-IR offers different sampling strategies depending on the type of analysis required. Extractive measurements provide a low maintenance approach for simultaneously determining concentrations of several species, including CO, CO_2, NO, and SO_2 with high sensitivity. Alternatively, in-situ measurements can be used to determine concentrations of species that are otherwise difficult to monitor, for example, NH_3 and HCl. The capability to measure NH_3 concentrations is particularly useful for monitoring and, potentially, controlling the urea injection process used for NO_x reduction. Although FT-IR is an established multicomponent sensor technology, the use of FT-IR for CEM and process monitoring and control systems in power plants is still in the developmental stages, particularly in the case of in-situ measurements. In this work, we describe the development and testing of an in-situ FT-IR spectrometer system for process monitoring and control of selective non-catalytic reduction (SNCR) of NO_x using the Nalco Fuel Tech (NFT) NO_xOUT™ process.

In-situ FT-IR measurements were made at two locations in the facility, approximately 1.6 meters downstream from the injection point (upstream zone), and approximately 5.7 meters downstream from the injection point (downstream zone). The temperature at the upstream zone was typically in the range of 700-850°C, and the temperature in the downstream zone was usually between 450 and 550°C. In both locations, the facility was modified to provide optical access to the effluent stream through directly opposed 2 inch ports. An 8 inch extension pipe was attached to each port in order to facilitate the installation of infrared transparent windows. An On-Line Technologies Model 2100 FT-IR spectrometer was mounted with the 1 inch diameter collimated beam directed through the port. Focusing optics and a liquid nitrogen-cooled, narrow-band MCT detector were installed at the opposite port. An On-Line Technologies' modification of LabVIEW (National Instruments) software was used for FT-IR data collection and processing, acquisition of thermocouple data, and control of the reagent injection pump. This software package provides a user-friendly, graphical programming environment for the development of process monitoring and control software based on FT-IR measurements. Simultaneous measurements of NO, NH_3, and CO were used to develop simple neural network models of the NO_xOUT™ process under: (1) well defined operating conditions; (2) widely varying operating conditions; and (3) during a period when faulty data were being obtained. In addition, the capability of the neural network models to generalize (correctly predict for data which were not used for training), was demonstrated for all three data sets. The flexibility and fault tolerance of the neural networks demonstrated that implementation of neural network model-based control would be advantageous for the NO_xOUT™ SNCR process and related processes.